# A Pulsed NMR System for Polarization Measurements in Solid State Targets

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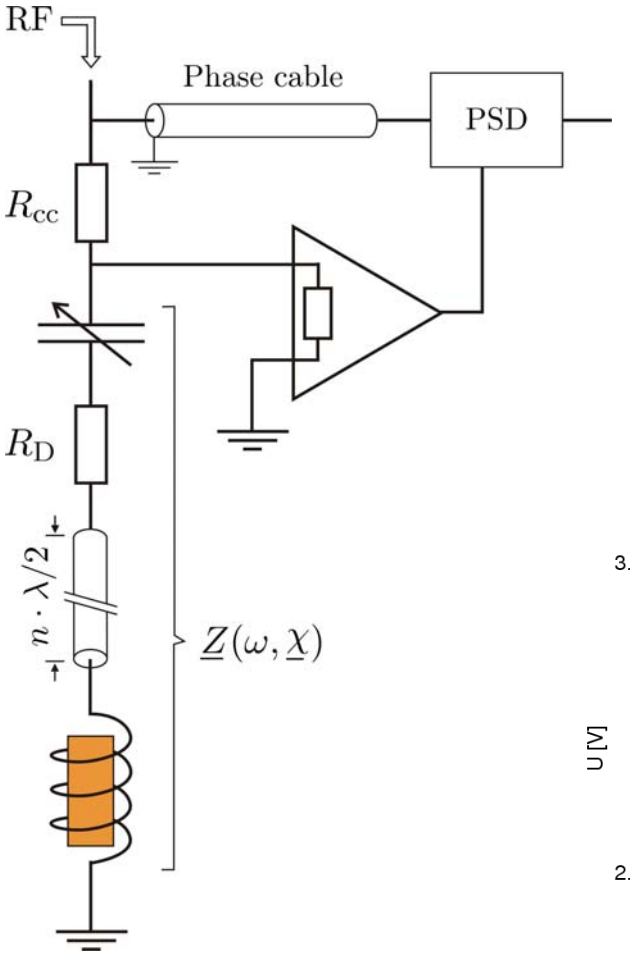
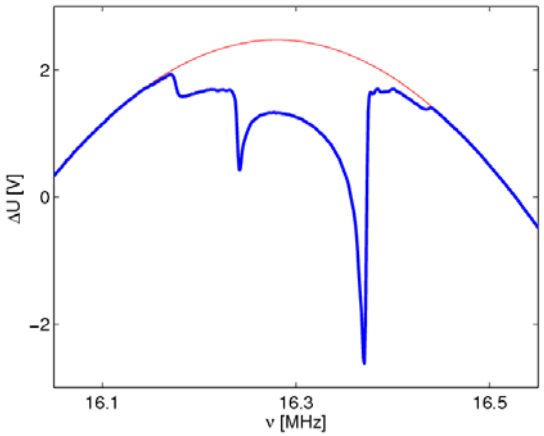
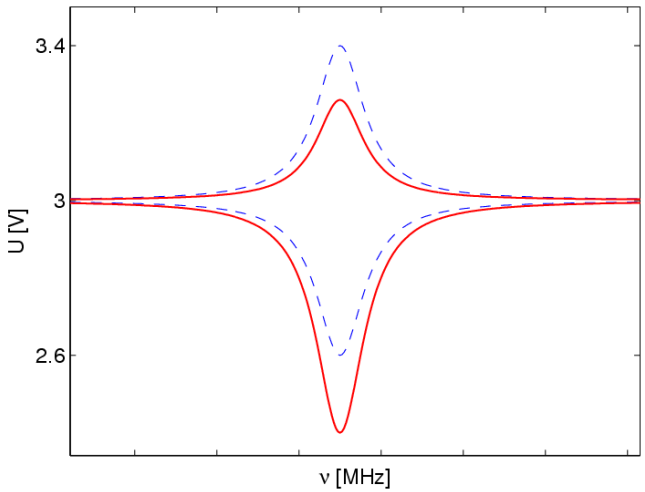
- Continuous wave technique
- Principle of pulsed NMR
- Experimental setup
- FID detection
- Measured NMR spectra
- Polarization measurement
- Improvement of the exprimantal setup
- Summary and outlook

# Continuous Wave Technique




**Nonlinearities:**

broadened signals

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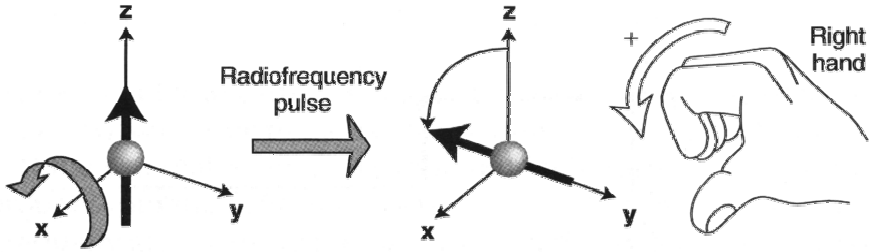
deformations at the edges

high polarization

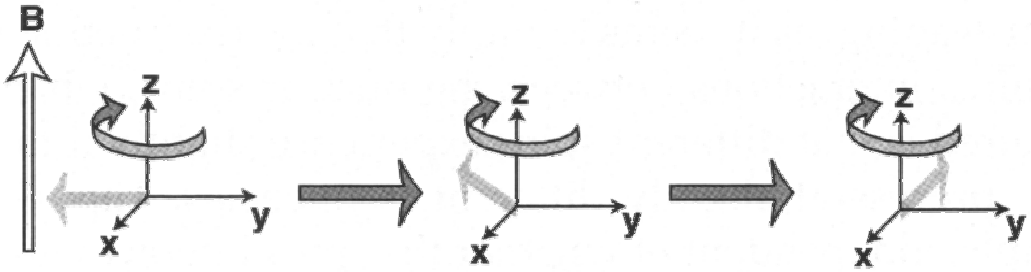
⇩

different sensitivity for positive and negative polarization

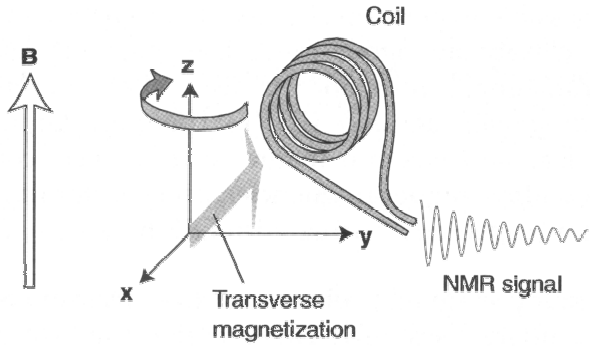
# Principle of Pulsed NMR




By applying an rf pulse, every single spin is tipped out of the $B_0$ direction.
This causes a net transverse magnetization.



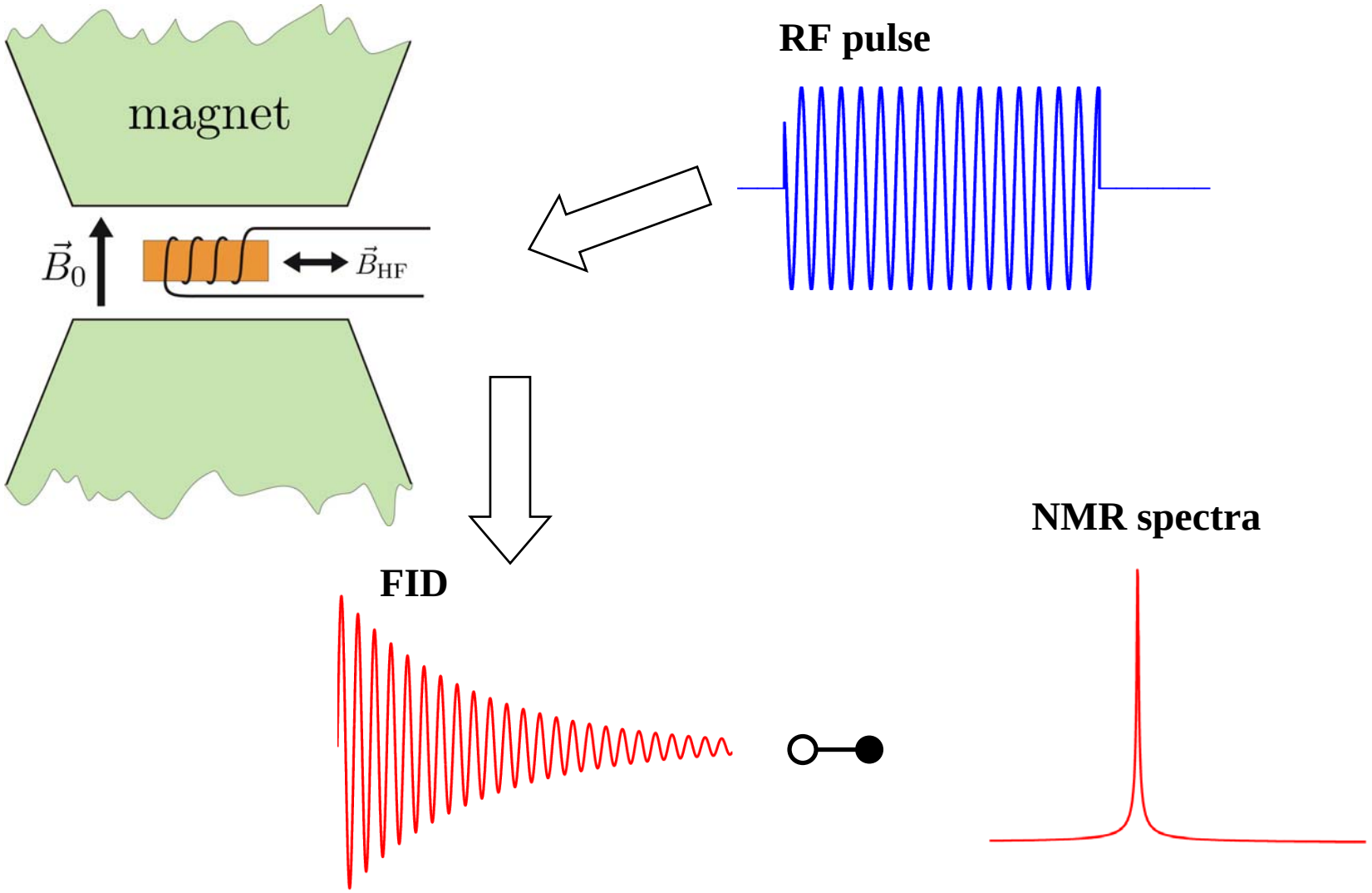

Because every single spin starts its precession motion, the transverse magnetization also precesses around the magnetic field.



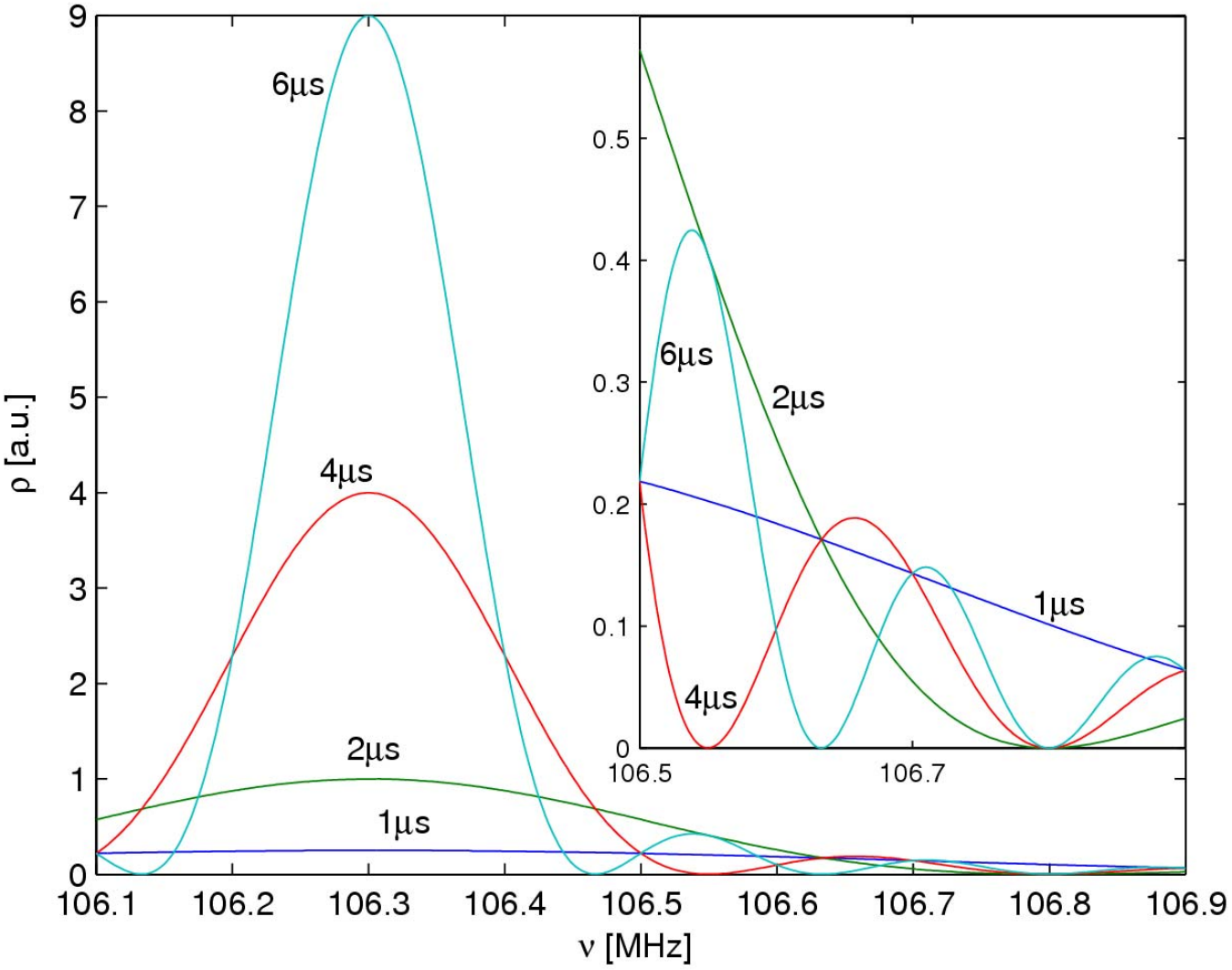

The rotating magnetic moment inducts an oscillating signal in the receiver coil.

→ **free inductance decay (FID)**

# Principle of Pulsed NMR



# Excitation Spectra




**spectral energy density:**

$$\rho \sim \left[\frac{\sin\left((\Omega-\omega)\frac{T_\mathrm{p}}{2}\right)}{\Omega-\omega}\right]^2$$

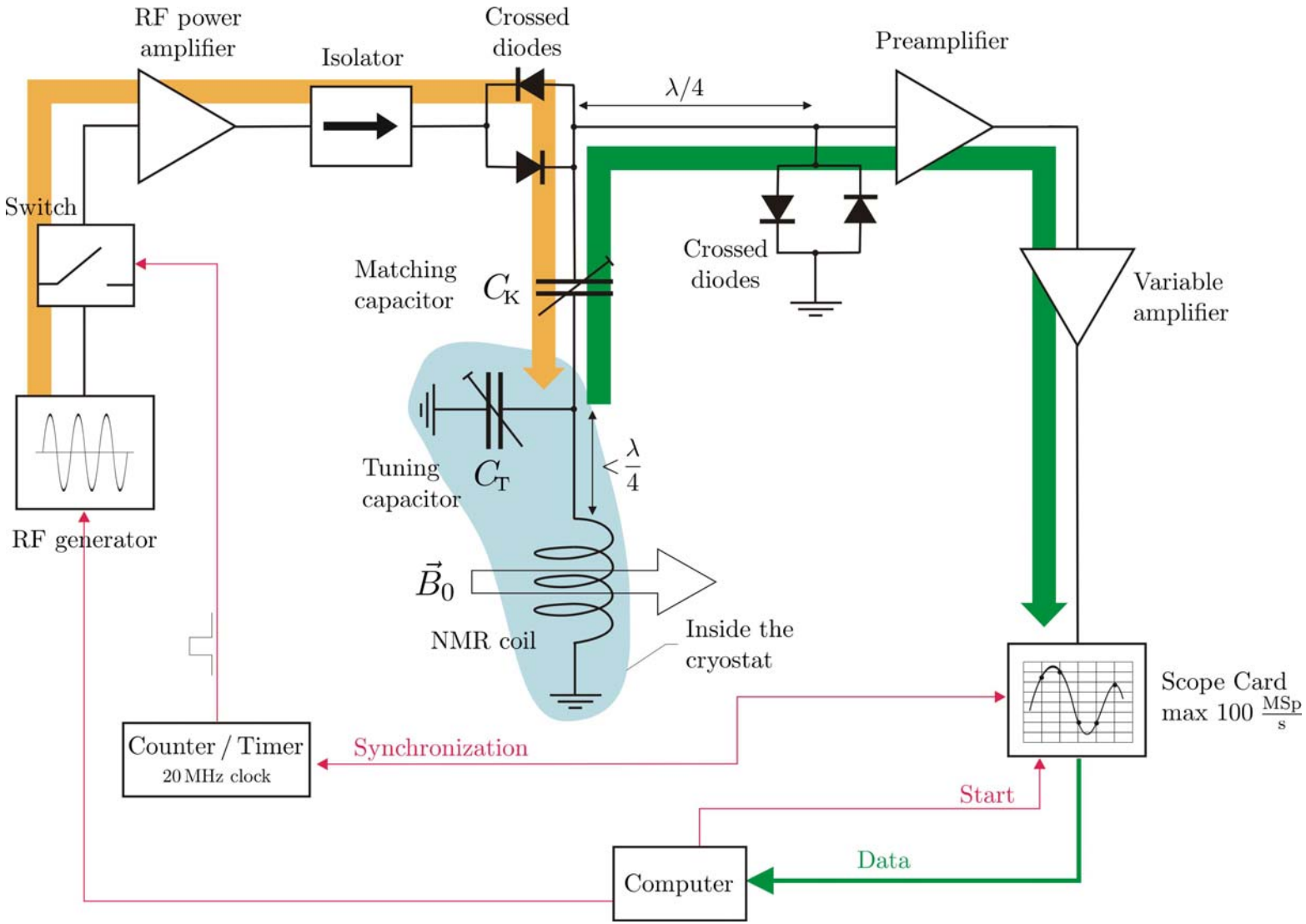
**maximum amplitude:**

$$\rho_{\max} = \frac{P_{\mathrm{HF}} T_\mathrm{p}^2}{2\pi}$$

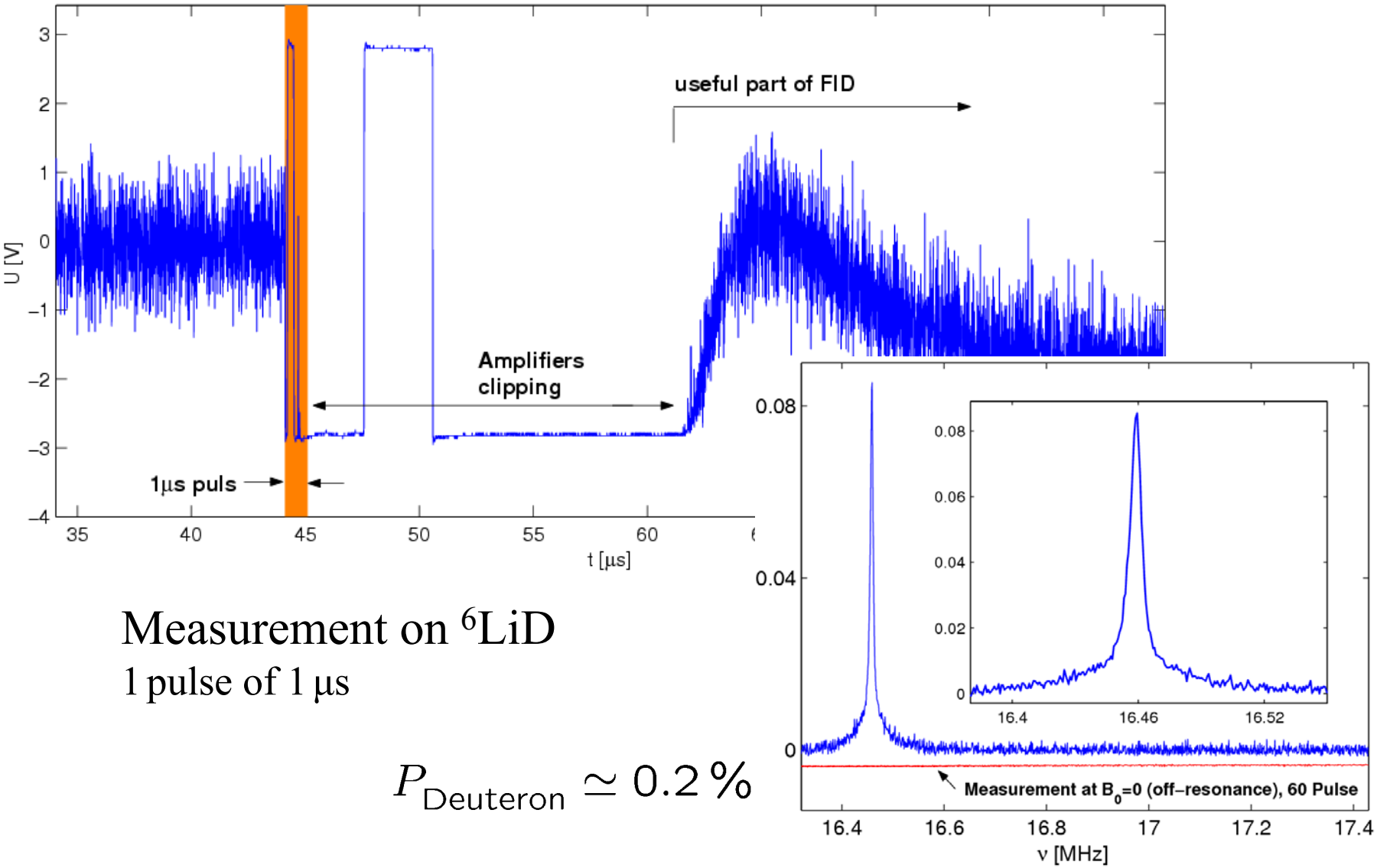
**FWHM:**

$$\Gamma_\nu = \frac{0.886}{T_\mathrm{p}}$$

# Experimental Setup . . . so far



# FID and NMR Signal



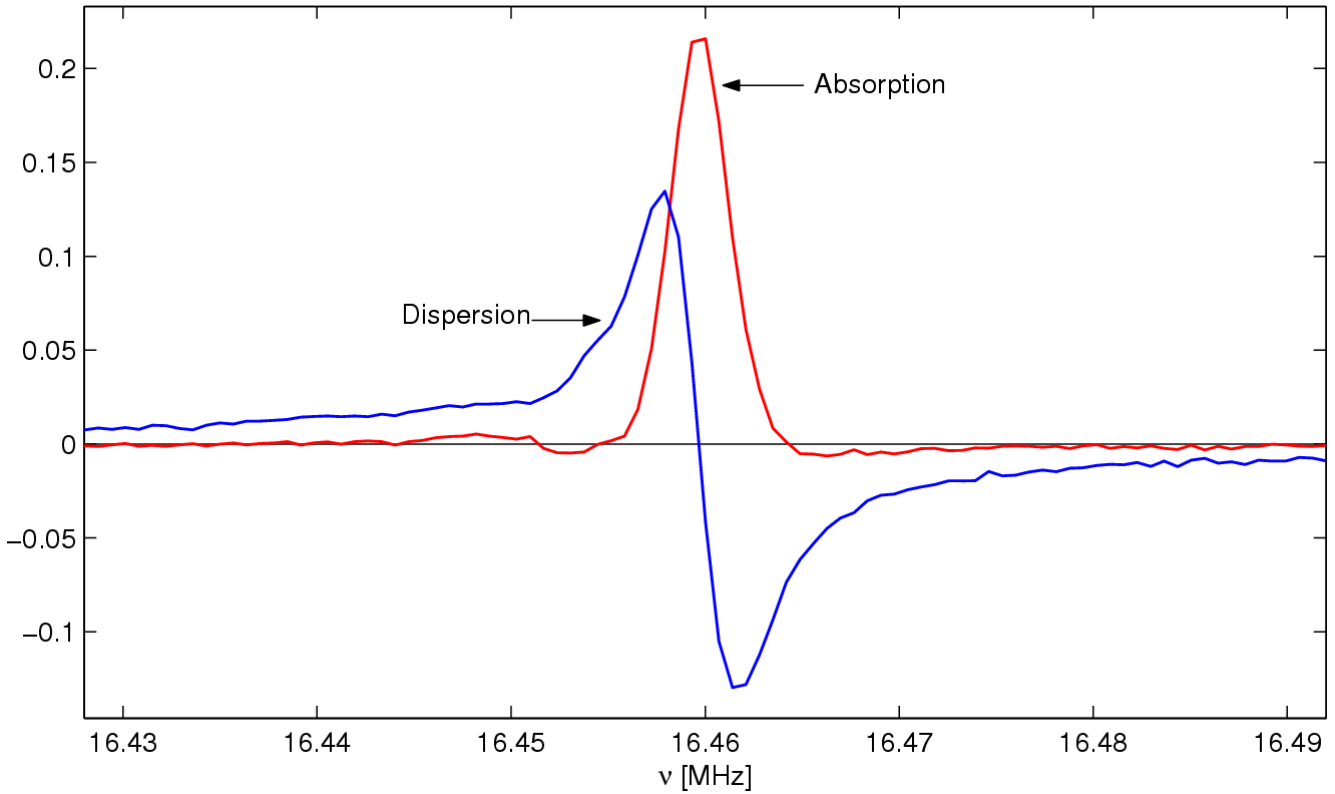

Measurement on $^{6}$LiD

1 pulse of 1 µs

$$P_{\text{Deuteron}} \simeq 0.2\,\%$$

# Absorptive and Dispersive Signal

**Deuteron signal from $^{6}$LiD**




complex FT

⇩

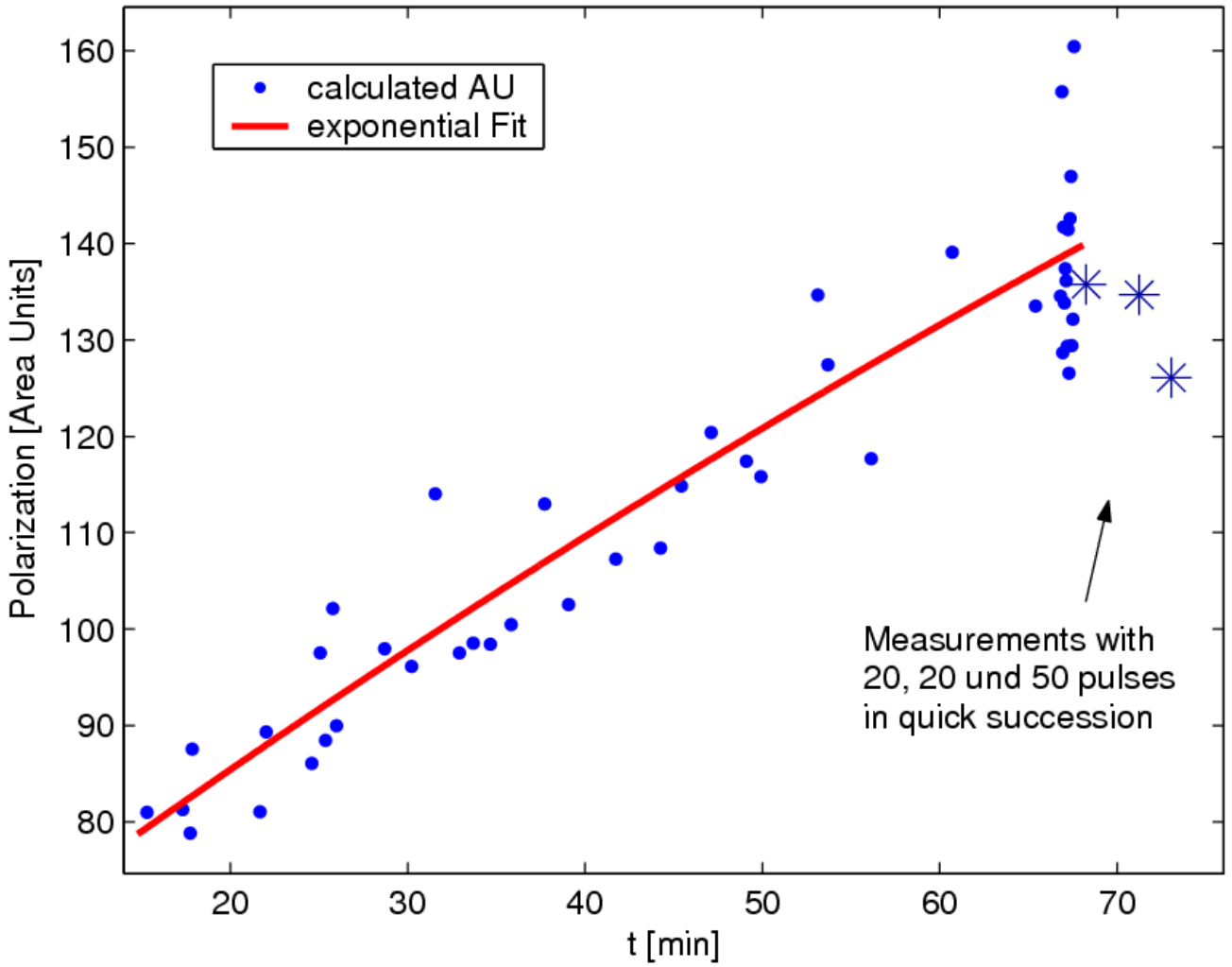
absorptive- and dispersive part

pulses with fixed phase

⇩

automized calculation of absorptive and dispersive signal from the FID

# TE Polarization Build-up Curve




**Deuteron polarization in $^{6}$LiD**

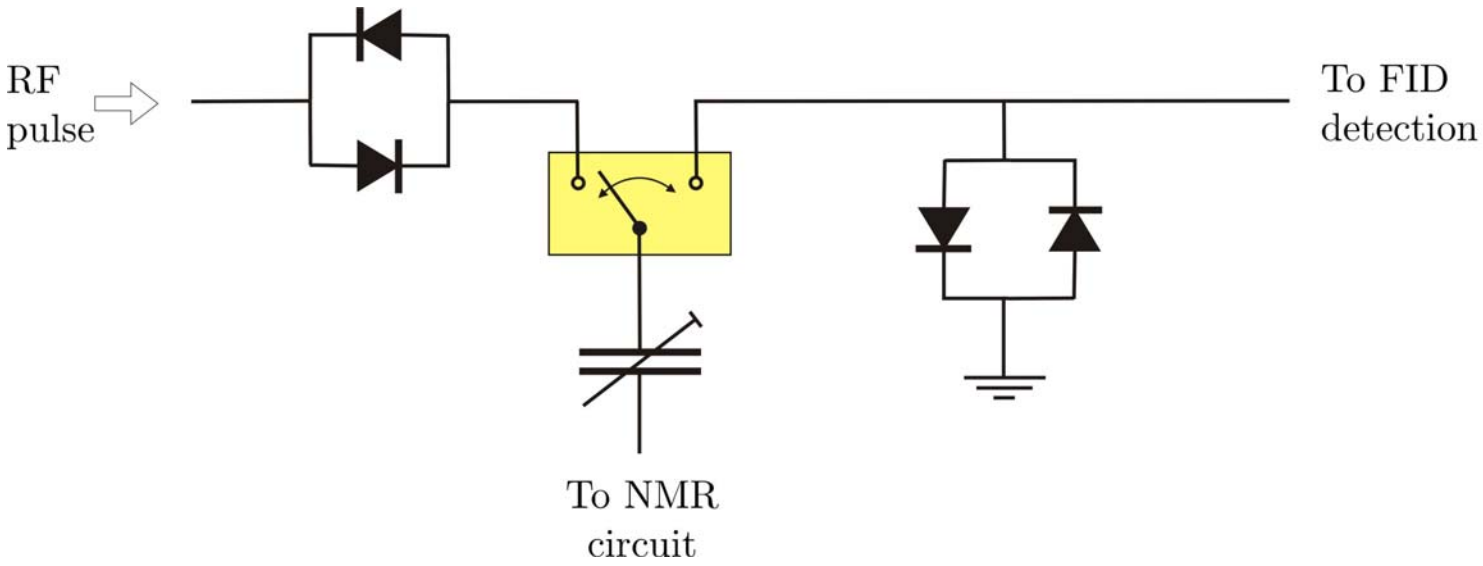
$$P_{\mathrm{D}} \simeq 0,02\,\%$$

- small fluctuations between measurements
- Polarization build-up in evidence
- slightly destruction of polarization by many pulses

# Improved Experimental Setup

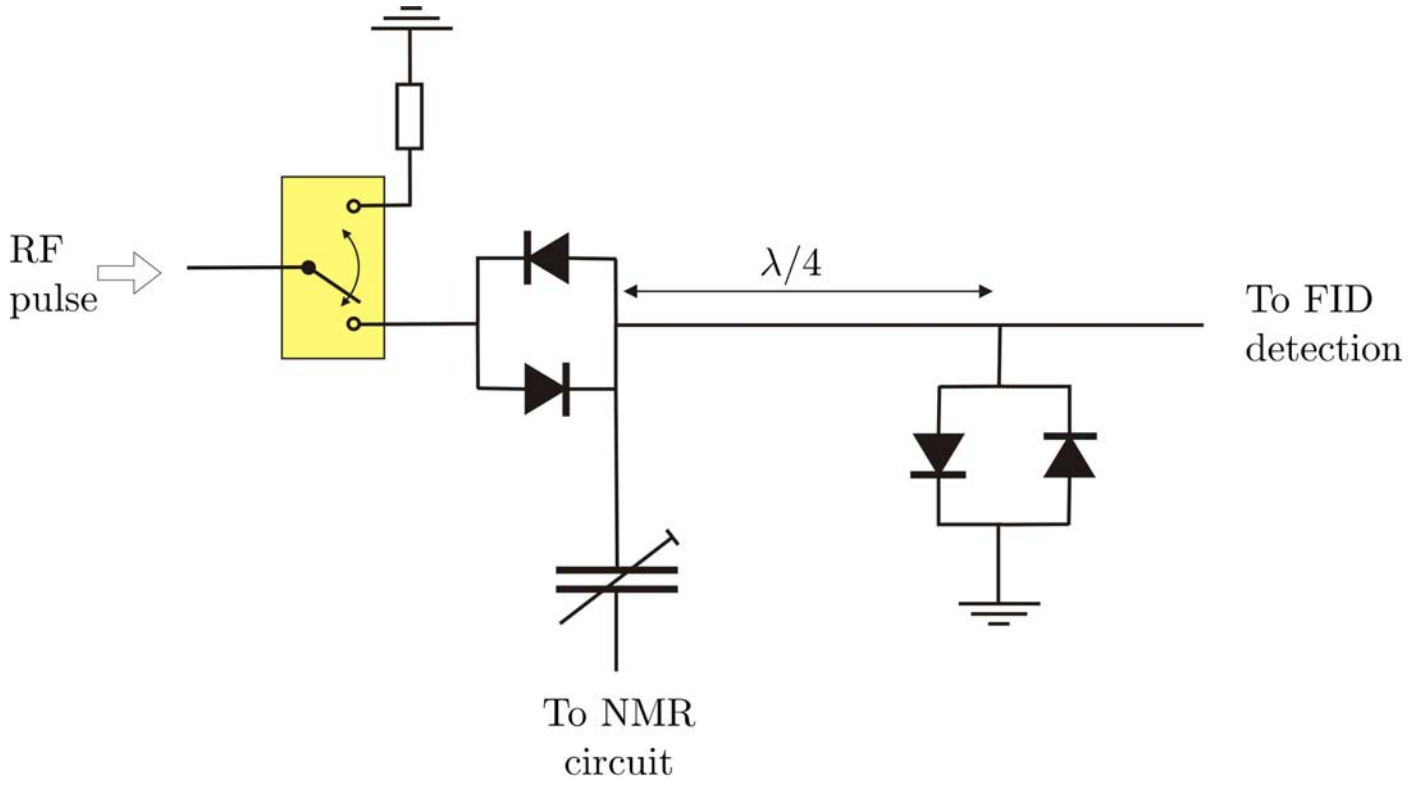
Pin diode switch to eliminate noise during FID detection

**1st option**



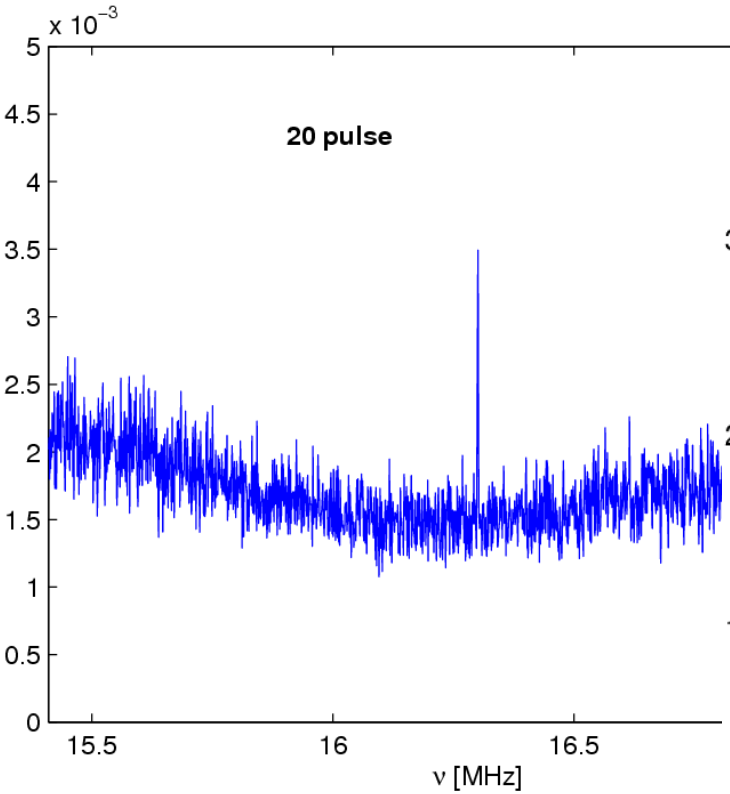
# Improved Experimantal Setup

**2nd option**

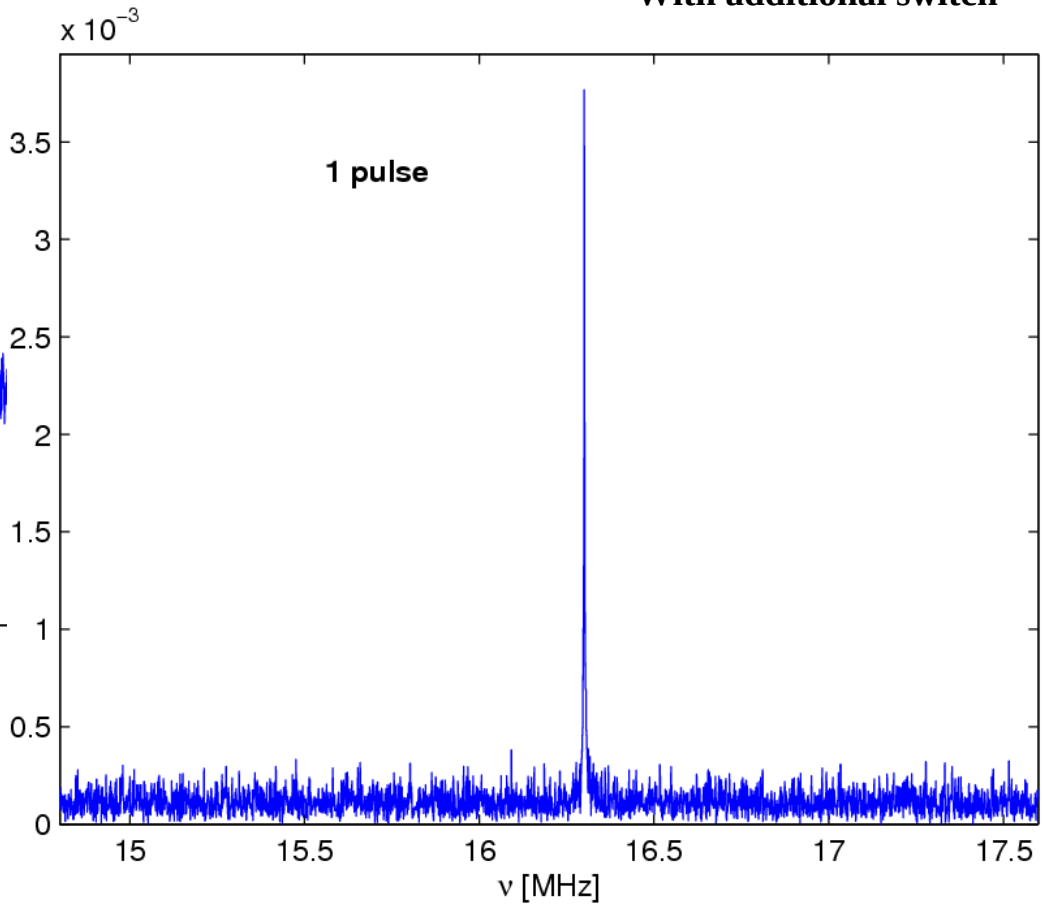


# The Effect of Active Switching

**With diodes only**




**With additional switch**




D-Butanol @ 300K
$T_{pulse}$ = 6 µs

# Summary and Outlook

- Measurement of deuteron polarization with pulsed NMR works
- Good results, even for TE signals
- Very fast technique

- Increase of sensitivity by using additional switch
  - To be tested under DNP conditions
- Enables measurements of short $T_1$
  - e.g. for HD – but no experience yet
- Active phase control to separate absorptive and dispersive part